Photonic Signal Frequency Up and Down-Conversion Using a Photonic Band Gap Structure

Abstract

A photonic band gap (PBG) device is provided for frequency up and/or down-converting first and second photonic signals incident on the device to produce a down-converted output photonic signal. When the first and second incident photonic signals have respective first and second frequencies ω_3 and ω_2, the down-converted photonic signal has a third frequency $\omega_1 = \omega_3 - \omega_2$. When the first incident field has a frequency ω_1 , the first up-converted photonic signal has a second frequency ω_2. The second up-converted photonic signal has a third frequency $\omega_3 = \omega_1 + \omega_2$. Thus, the PBG device can be used to generate coherent near- and mid-IR signals by frequency down-converting photonic signals from readily available photonic signal sources, or red, blue, and ultraviolet signals by up-converting the same readily available photonic signal sources. The PBG device includes a layered stack having a plurality of first material layers and a plurality of second material layers. The first and second material layers are arranged such that the PBG device exhibits a photonic band gap structure exhibiting first, second and third transmission band edges respectively corresponding to the first, second, and third frequencies. An interaction of the first and second photonic signals with the arrangement of layers in the metal stack causes a mixing process to generate the both up and down-converted photonic signal at the third frequency.

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